Adhesion Protocol for Bonding Abutments or Fixed Dental Prostheses on Titanium Bases in Implant-borne Reconstructions: How and Why?

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Adhesion Protocol for Bonding Abutments or Fixed Dental Prostheses on Titanium Bases in Implant-borne Reconstructions: How and Why?

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IAAD WORKING INSTRUCTIONS

Question: What is the best surface conditioning and bonding protocol sequence for durable adhesion of abutments, crowns, or fixed dental prostheses (FDPs) to a titanium base used in implant-borne reconstructions?

Answer: Recently, adhesive procedures have also become necessary in implant dentistry when bonding implant components to one another. Non-engaging or engaging implant abutment connections are made of titanium (in the following: titanium base) in order to connect implants to abutments, single crowns, or FDPs, as this material presents biocompatibility, high corrosion resistance, and superior mechanical properties compared to other materials.[4] Typically, ceramic crowns are extraorally adhesively bonded to a titanium base (height: 3.5 to 5.5 mm) using adhesion promoters and resin-based luting cements, and are then screwed onto the implant.[5] This procedure eliminates the flow of possible excess cement during intraoral cementation; peri-implantitis can result if the excess cement is not removed properly.[2] Durable adhesion of resin cements to titanium and ceramic abutments or FDPs prevents possible prosthetic and biological complications, such as fracture of the FDP or bone loss.[5] Since adhesive protocols for such procedures are not fully described as guidelines in implant dentistry reports, the following surface conditioning and bonding protocol may be recommended based on the available scientific reports:

Do	Why?
After clinical try in, the titanium base, abutment, or crown should be ultrasonically cleaned in distilled water for at least 5 min, then dried.[7]	Strong, durable adhesion depends on adequately cleaning the titanium base and prosthetic parts of metallic debris, saliva, blood, and other contaminants.
Coat the emergence profile of the titanium base with glycerine gel.	Isolation of this part prevents blasting damage to the polished areas of the titanium base that will be in contact with the peri-implant soft tissues.
Air abrade the connection and the platform of the titanium base using an air-abrasion device, holding the nozzle perpendicular to the surface at a distance of approximately 10 mm for approximately 20 s/cm^2 in circling motions at 2.8 bar until a matte surface is obtained. Air abrasion should be performed gently, using controlled particle size (eg, 30-µm CoJet or 110-µm Rocatec Plus, 3M ESPE; St Paul, MN, USA).[8]	Air abrasion generates physicochemical alterations on the titanium surface, as this procedure mechanically removes the surface oxide layer. After air abrasion, a new, thin, stable oxide film is formed.[12] This film improves the chemical reaction with the functional monomers.[3,13] Air abrasion using silica-coated alumina particles yields higher bond strength than using alumina-only particles, indicating that particle morphology and particle coating affect adhesion to titanium.[3,7]
Ultrasonically clean the titanium base in distilled water for at least 5 min and dry with oil-free air.[7]	Loose particles remaining after air abrasion may compromise wettability of the silane or the primer. Ultrasonic cleaning eliminates such remnants at best.[7]
Apply one coat of silane coupling agent on the air-abraded surface. Wait for its reaction for at least 1 min.[6] Dry the solvent with oil-free air. Never touch the silica-coated surface with fingers, but use pliers. Use a new, fine brush for each silane application.	Silane coupling agents improve wettability and promote covalent bonds on the titanium surfaces, increasing the bond strength of resin-based luting cement.[12] They combine three functional methacrylates: silane methacrylate, phosphoric methacrylate, and sulfide methacrylate. Primers containing MDP (methacryloyl-oxydecyl dihydrogen phosphate) (eg, Monobond Plus) have a high affinity for the oxide layer created, improving the bond strength to the titanium surface.[12]
Manipulate the chemically (for metal-ceramic abutments or FDPs) or dual-polymerizing resin-based luting cement (for all-ceramic abutments or FDPs) containing MDP according to the manufacturer's instructions. Apply the cement on the titanium surface and position the abutment or the FDP on the base. Remove the excess cement and hold the parts in position throughout the polymerization.	Resin cements containing dual functional monomers, such as MDP, have both methacrylate and phosphate groups in their long backbone molecules. Some of these may be dual polymerizing. Cements containing MDP react chemically with the oxide layer created on the titanium surface.[12,14] These metal oxides form covalent as well as hydrogen bonds, and generate Van der Waals forces to the monomers of the resin cement, producing high bond strength.[1,6]
Photopolymerize for 60 s from each direction. Coat the margins of the abutment or FDP with glycerin gel for oxygen inhibition, wait for 10 s, rinse, and photopolymerize again for 60 s from each direction.	Make sure that the light output is more than 400 mW/cm^2 for better polymerization of the resin-based luting cement at the margins of the titanium base and the FDP material.[11]

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CAVE: If the abutment material is also titanium, the protocol above should be applied on the abutment, and the FDP should be subsequently bonded. In the case of zirconia abutments, previously published working instructions for zirconia substrate can be followed.[10] For conditioning the intaglio surfaces of the FDP, the same protocol presented above can be employed for titanium-metal/ceramic, but for other metals other conditioning methods may be needed.[6] If the FDP material is glassy matrix ceramic[9] or zirconia,[10] please refer to the corresponding working instructions for these substrates. For glassy matrix ceramics, methacrylate-based resin cements are suitable, but due to the presence of titanium in the base, a resin cement containing MDP should be used for more reliable adhesion of the prosthetic components to titanium. Please note that implant manufacturers of titanium bases do not recommend any surface conditioning method.

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